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GB 2081387 A GB 2061395 A GB 1580805 A
WO 86/06139 A1 WO 84/00583 A1 US 3989951 A

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UK CL (Edition M) F1S
INT CL[5] F03B 13/00 13/12 13/14 13/16 13/18 13/20 13/24
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(54) **Extracting energy from waves**

(57) A method and an apparatus for generating electricity from wave energy which comprises a plurality of juxtaposed chambers (10) located along a gradient below sea level. Each chamber (10) is connected to its next adjacent chamber by one-way valve means (12) and bellows or diaphragm members (11) are located above said chambers (10), one for each chamber (10). Wave action, acting upon such members (11), provides a pressure differential between the two most remote chambers (10) which is utilised for generating electricity. A plurality of rows of chambers may be used with interconnections therebetween (figure 4). The chambers may be made from reinforced concrete which may be moulded in situ.

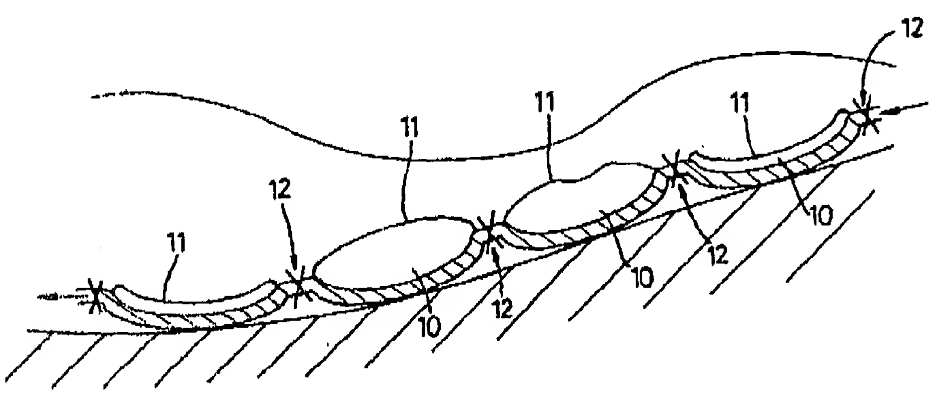

Fig. 1

GB 2 282 188 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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24 11 94

1/3

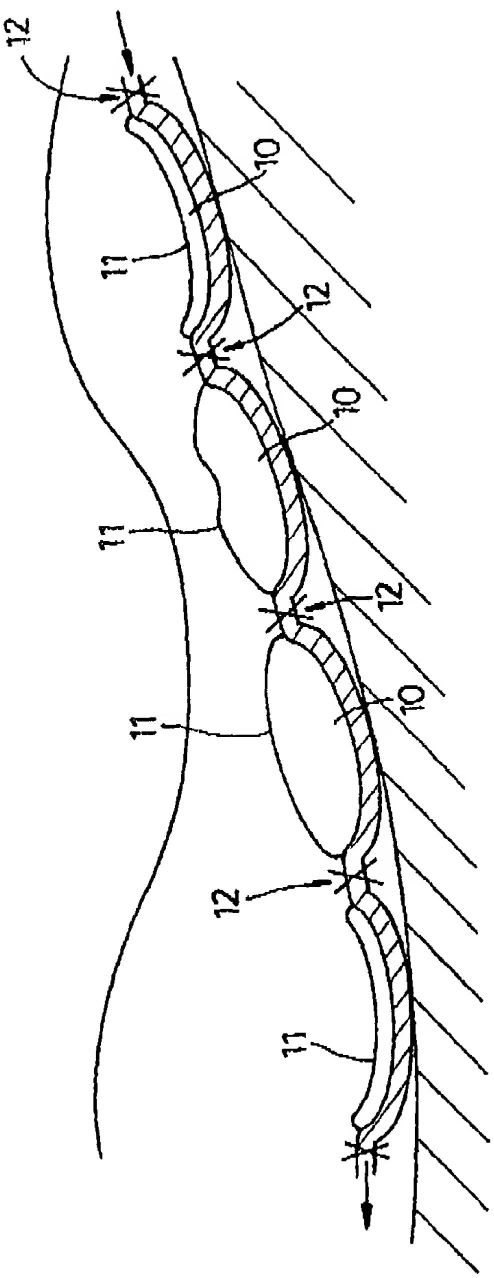

Fig.1

24 11 04

2/3

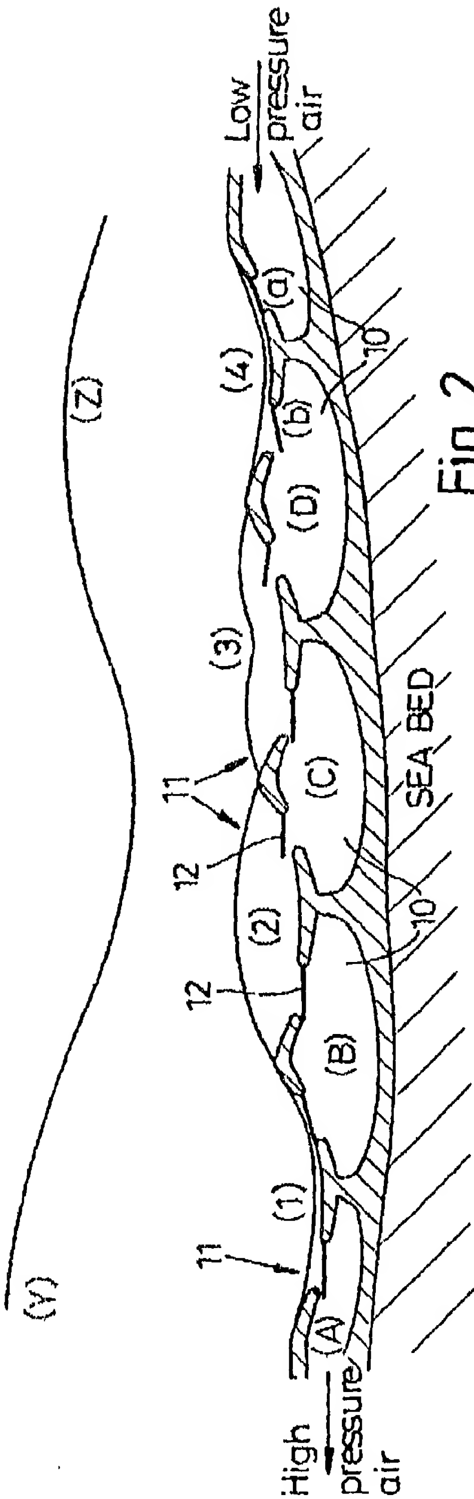

Fig. 2

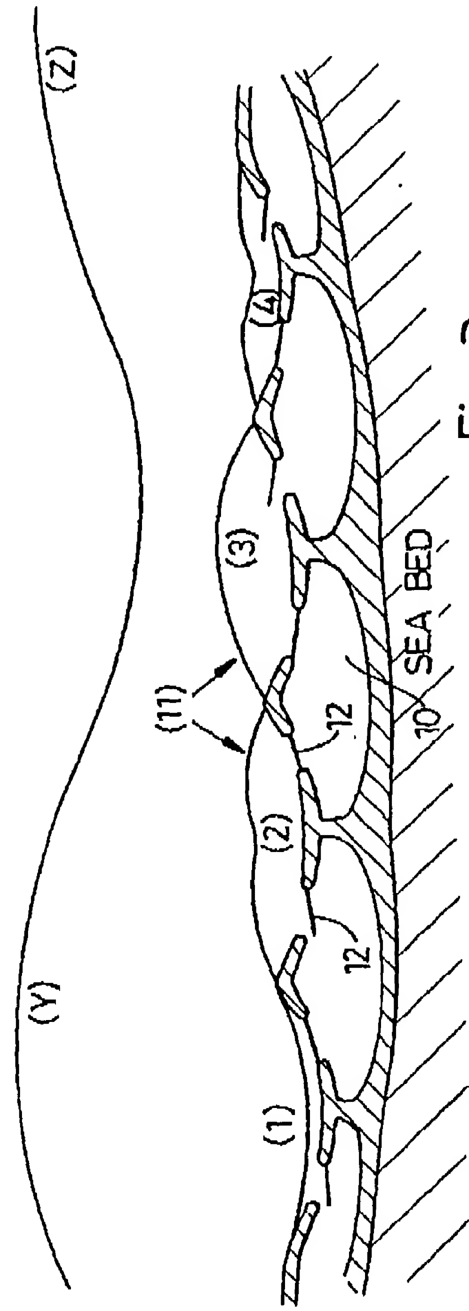

Fig. 3

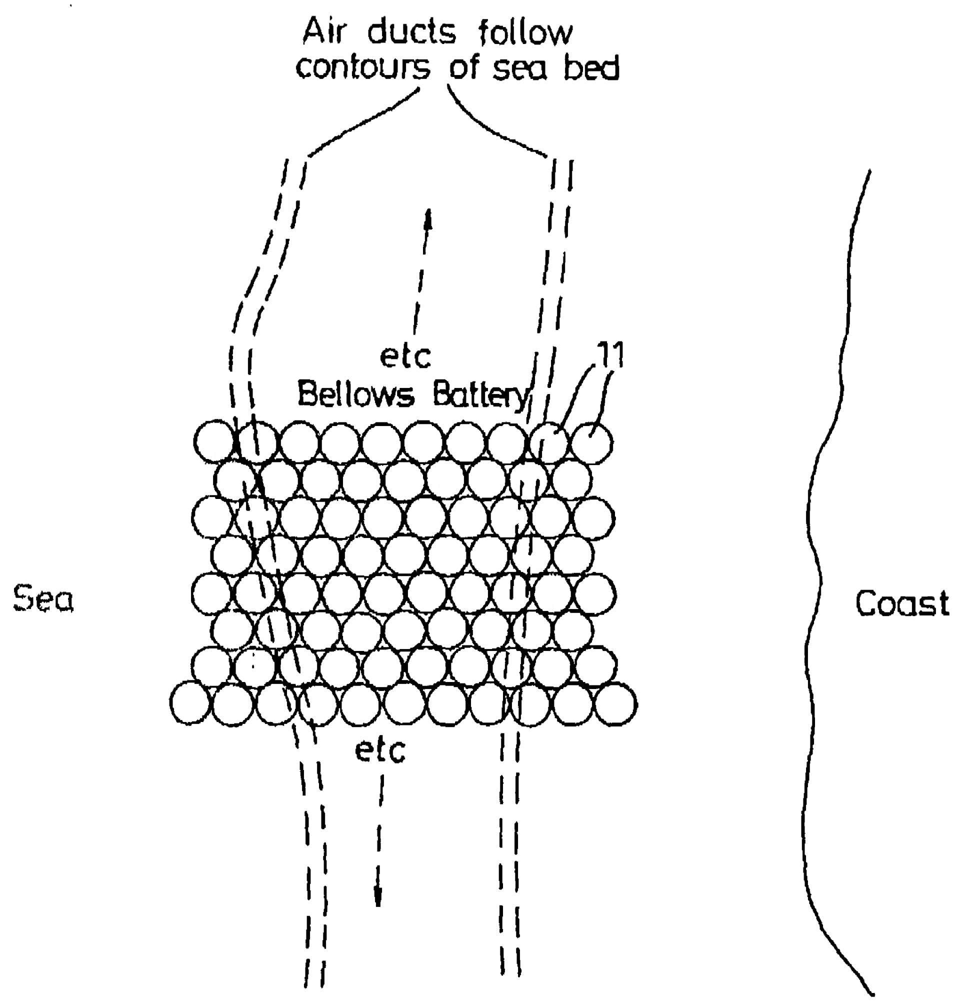
Air ducts follow
contours of sea bed
etc
Bellows Battery
11
etc
Sea
Coast

Fig. 4

IMPROVEMENTS IN AND RELATING TO THE GENERATION OF ELECTRICITY

The invention relates to the generation of electricity and more particularly to methods and apparatus for the generation of electricity utilising wave energy.

Many schemes have been proposed for utilising wave energy for generating electricity, some of which are disclosed in report ETSU-R-72 published by The Department of Trade & Industry in 1992 and entitled "A Review of Wave Energy". The majority of the known arrangements are located at or above sea level, so being environmentally unfriendly and being subject to damage by extreme weather conditions, and all are extremely inefficient in their conversion of wave energy.

It is an object of the invention to obviate or mitigate the above disadvantages.

According to one aspect of the invention there is provided a method of generating electricity from wave energy which comprises, locating a plurality of juxtaposed chambers along gradient below sea level, connecting each chamber to its next adjacent chamber by a one-way valve and locating bellows or diaphragm members one above each of said chambers to enclose a volume therewith, whereby wave action, acting upon such members, provides a pressure differential between the two most remote chambers which is utilised for generating electricity.

According to a further aspect of the invention there is provided a method of generating electricity from wave energy which comprises, locating a plurality of juxtaposed chambers along a gradient below sea level, connecting each chamber to its next adjacent chamber by respective one-way valves and locating

bellows or diaphragm members above said chambers. each said member enclosing a volume above two adjacent chambers and spanning an oppositely acting one-way valve of each chamber, whereby wave action, acting upon such members, provides a pressure differential between the two most remote chambers which is utilised for generating electricity.

The juxtaposed chambers may be located on or adjacent the sea bed and arranged to extend outwardly from a beach or shoreline generally in the direction of wave motion.

A plurality of rows of juxtaposed chambers may be provided and respective adjacent chambers may be interconnected laterally across the rows.

The row(s) of juxtaposed chambers may be formed of reinforced concrete which may be moulded in situ or may be provided as preformed sections.

Air may be introduced into the chambers nearest the beach or shoreline at low pressure and exhausted at higher pressure at the remote chambers. Such compressed air may be utilised to raise water to a high level water reservoir, for example with peristaltic pipes and may then be utilised for the generation of electricity by conventional hydroelectric means.

According to yet a further aspect of the invention there is provided an apparatus for generating electricity from wave energy which comprises a plurality of juxtaposed chambers located along a gradient below sea level, each chamber being connected to its next adjacent chamber by one-way valve means, and bellows or diaphragm members located above said chambers, one for each chamber, whereby wave action, acting upon such members, provides a pressure differential between the two most remote chambers which is utilised for generating electricity, in use.

Each bellows member may comprise a sheet of strong flexible synthectic plastics material and may be in the order of five meters in diameter.

The juxtaposed chambers may be formed in situ from reinforced concrete or may be provide as preformed sections, and located at or near the sea bed.

The foregoing and further features of the invention may be more readily understood from the following description of some preferred embodiments thereof, by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic side sectional view of an apparatus of one embodiment of the invention;

Fig. 2 is a schematic side sectional view of an alternative apparatus in a first condition relative to the first wave position;

Fig. 3 is a view similar to Fig. 2 in a second condition relative to a second wave position, and

Fig. 4 is a plan view of a typical apparatus as shown in Figs. 1, 2 and 3.

Referring now to Fig. 1 of the drawings there is shown schematically an apparatus for utilising wave energy for generating electricity. A plurality of chambers 10 each having an upper surface formed by a diaphragm or bellows 11 are juxtaposed with one-way valves 12 therebetween. The chambers 10 are located at or near the sea bed and the operation of this apparatus is similar to that described in detail in respect of the embodiment of Figs. 2 and 3.

Waves rolling in upon a coast exert varying pressures on points on the sea bed determined by alternate crests and troughs as they pass. Thus if a shallow concrete dish, over which is sealed a strong flexible plastic sheet, is placed on the sea bed and if that dish and sheet contain air, the pressure of that

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air will vary as the waves roll in over the assembly. So the arrangement can be made to function as a bellows. As the bellows are well below the surface it will not be subject to the damaging surface turbulence.

Fig. 2 shows a series of four such bellows 11 arranged on a sea bed shelving towards the beach, with waves rolling in above them. Each bellows is about 5 metres in diameter and below and between each is an air chamber 10. Non return air valves 12 connect the various components as shown.

Air is fed into bellows (4) through valve (a) from a low pressure air reservoir (not shown) at a pressure controlled to be between that exerted on the bellows by succeeding wave crests and troughs. Thus, as a trough passes over a bellows, air will enter that bellows. It will be seen (Fig. 2) that wave crest (Z), being over bellows (4), will force the air from that bellows through valve (b) into chamber (D) where it will be trapped by the closing of that non-return valve. The air pressure in chamber (D) will now be that due to the height of the wave crest (Z) above bellows (4). As the waves roll in to the position shown in Fig. 3, where the trough between wave crests (Y) and (Z) is over bellows (3) the water pressure on that bellows is less than the air pressure in chamber (D), so the air in (D) will be transferred to bellows (3). As wave crest (Y) rolls over bellows (3) it forces the air into chamber (C) and, since (C) is at a lower level than (D), that air will be at a correspondingly higher pressure that it was when it was in (D). As successive waves roll in, air is steadily transferred to chambers (B) and then (A), absorbing energy from the waves and increasing the air pressure as it is forced under deeper and deeper water. The air in chamber (A) is then passed into a high pressure air reservoir (not

shown) while bellows (4) is fed with air from a low pressure reservoir (not shown), whose pressure is appropriately controlled as mentioned above.

It will be noted that in the above arrangements, where the non-return air valves are installed to pass air to lower levels only, the system will function no matter from which direction the waves approach. The wave length or frequency does not have any relevance to the positioning of the bellows or their size, provided that the wave length is more than twice the bellow's diameter.

Each bellows operates as an independent unit no matter from which direction waves approach or what their frequency is. Even if the crests of the waves lie parallel to the line of the bellows in Figs 2 & 3 the pumping action will function normally, the only difference being that a wave crest will pass over all four bellows simultaneously, forcing the air into all four chambers at the same time; when the next trough passes all four bellows will refill together.

The foregoing is diagrammatic and simplified in order to demonstrate the principle of the bellows action. In fact a bellows battery containing a large number of bellows would be used and a plan view of such a battery is shown at Fig 4. In this arrangement, although each bellows remains individual, the air chambers are joined together horizontally to form air ducts along the length of the battery and running along contours of the sea bed. Thus a constant pressure over the entire length of the duct would be maintained. It is envisaged that the seaward duct would be about 10 metres lower than the in-shore duct, giving a constant pressure difference between a high and a low pressure air reservoir. The actual pressures would vary with the state of the tide, requiring the control of the

input pressure to the inshore duct, but the pressure difference would be constant. This is relevant as regards the next function of using that air pressure to pump water to high level water reservoir.

It might be thought that the pressures involved in such an installation would be too great for the plastic sheets to stand and they would split. It is emphasized that, provided enough "slack" is built into those sheets, very little strain would be imposed upon them. They serve simply as membranes dividing air and water, the pressures of which are equal and opposite.

It is well known that the water within a wave performs a circular or rolling motion. The water at the top of that circle moves in the same direction as the wave crest though slower while the water at the bottom of the circle moves in the opposite direction as the trough passes. So in Fig. 1 with wave moving from the left to right the rolling motion is clockwise and gets weaker as depth increases.

If the only energy outlet is the seas' surface then the rolling motion is as described above, However, if there is another energy outlet on the sea bed as in this case that rolling motion will be as above in the top half of the water but will reverse and increase in strength from that half way level to the sea bed when its strength will be once again that at the surface.

Originally it was intended that the presently proposed bellows battery should be sited around the 10 metre depth contour (ie. between 5m and 15m) where the sum of the losses from the bottom drag and the ratio of bottom pressure to surface amplitude is minimum if no reversal of rolling motion occurs. For example, from the measurements reported in ETSU-R-72 of average bottom drag over four sites on the West of the U.K, bottom drag reduced the energy in a wave on the 10m

contour to 38% of its original energy in deep water. This 38% is further reduced to 32% by the depth of the sea bed (0.85 for a 11.5 second period). However, if the rolling motion does reverse, the Bellows Battery could be sited in much deeper water, say in a depth of 42m at which depth the Bristol Cylinder (described in ETSU-R-72) would be sited.

Compared below is the energy collectable by the presently proposed bellows system and the Bristol Cylinder (which would seem to be one of the more favoured known devices):-

(a) <u>Bristol cylinder (moored at 42m, centre of cylinder at 14m)</u>

Wave energy in deep water	100%
Reduced at 42m by bottom drag to	58%
Reduced by directionality (35%) to	37.7%
Reduced by mixed frequency (50%) to	18.85%
Reduced by depth below surface (20%) to	15%

(b) <u>Bellows System (sited around 10m. NO reversal of rolling water)</u>

Wave energy in deep water	100%
Reduced at 10m by bottom drag to	38%
Reduced by directionality NIL	38%
Reduced by mixed frequency NIL	38%
Reduced by depth below surface (15%) to	32%

(c) <u>Bellows System (sited around 42m. Reversal of rolling motion present)</u>

Wave energy in deep water	100%
Reduced at 42m by bottom drag to	58%
Reduced by directionality NIL	58%
Reduced by mixed frequency NIL	58%
Reduced by depth below surface NIL	58%

Hence the bellows system would appear to be over twice as efficient as the Bristol Cylinder if no reversal of rolling motion occurs (32% as against 15%),

while it is nearly four times as efficient if the reversal does occur (58% as against 15%).

The bellows are each independent and function irrespective of their neighbour's performance so long as those neighbour's are functioning. It might be thought that a wave flowing over the outer bellows lines would give up all its energy to those lines and have none left to activate the inshore bellows lines. In such a case the outer lines would become starved of air. Those outer lines would indeed be starved of air but only temporarily. Should those outer bellows be empty, the inflowing waves would pass over them, retaining their energy to activate bellows further inshore. Similarly if a particularly small wave has insufficient height to activate the outer bellows line it will flow over those bellows, retaining its energy until it reaches a shallower part of the battery where it can give up its energy. The whole arrangement is self-adjusting in this and other respects.

The presently proposed bellows system has advantages over the other devices currently being developed as listed below:-

(a) It is uncomplicated and hence more likely to be reliable and less expensive to construct and maintain;

(b) It incorporates energy storage in its water reservoir to guard against calm periods;

(c) It is away from the damaging surface turbulence and surf;

(d) It is not subject to losses from directionality or mix frequency wave patterns;

(e) It is capable of expanding to supplant rather than augment conventional generating systems and is competitive with them;

(f) It is unobtrusive to other sea users; and

(g) It appears to be considerably more efficient in collecting wave energy than the Bristol Cylinder, which is one the more favoured known devices.

CLAIMS:

1. A method of generating electricity from wave energy which comprises, locating a plurality of juxtaposed chambers along a gradient below sea level, connecting each chamber to its next adjacent chamber by a one-way valve and locating bellows or diaphragm members one above each of said chambers to enclose a volume therewith, whereby wave action, acting upon such members, provides a pressure differential between the two most remote chambers which is utilised for generating electricity.

2. A method of generating electricity from wave energy which comprises, locating a plurality of juxtaposed chambers along a gradient below sea level, connecting each chamber to its next adjacent chamber by respective one-way valves and locating bellows or diaphragm members above said chambers, each said member enclosing a volume above two adjacent chambers and spanning an oppositely acting one-way valve of each chamber, whereby wave action, acting upon such members, provides a pressure differential between the two most remote chambers which is utilised for generating electricity.

3. A method as claimed in claim 1 or 2 wherein the juxtaposed chambers are located on or adjacent the sea bed and arranged to extend outwardly from a beach or shoreline generally in the direction of wave motion.

4. A method as claimed in any preceding claim wherein a plurality of rows of juxtaposed chambers are provided.

5. A method as claimed in claim 4 wherein respective adjacent chambers are interconnected laterally across the rows.

6. A method as claimed in any preceding claim wherein the juxtaposed chambers are formed of reinforced concrete moulded in situ.

7. A method as claimed in any one of claims 1 to 5 inclusive wherein the juxtaposed chambers are formed of reinforced concrete and are provided as preformed sections.

8. A method as claimed in claim 3 or any claim appendent thereto wherein air is introduced into the chamber(s) nearest the beach or shoreline at low pressure and exhausted at higher pressure at the remote chamber(s).

9. A method as claimed in claim 8 wherein the compressed air is utilised to raise water to a high level water reservoir and then utilised for the generation of electricity by conventional hydroelectric means.

10. An apparatus for generating electricity from wave energy which comprises a plurality of juxtaposed chambers located along a gradient below sea level, each chamber being connected to its adjacent chamber by one-way valve means, and bellows or diaphragm members located above said chambers, one for each chamber, whereby wave action, acting upon such members, provides a pressure differential between the two most remote chambers which is utilised for generating electricity, in use.

11. An apparatus as claimed in claim 10 wherein each bellows member comprises a sheet of flexible synthetic plastics material.

12. An apparatus as claimed in claim 10 or 11 wherein each bellows member is in the order of five meters in diameter.

13. An apparatus as claimed in claim 10, 11 or 12 weherein the juxtaposed chambers are formed in situ from reinforced concrete.

14. An apparatus as claimed in claim 10, 11 or 12 wherein the juxtaposed chambers are provided as preformed sections of reinforced concrete.

15. A method of generating electricity substantially as hereinbefore described with reference to the accompanying drawings.

16. An apparatus for generating electricity substantially as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report) -13 -	Application number GB 9319700.2
Relevant Technical Fields (i) UK Cl (Ed.M) F1S (ii) Int Cl (Ed.5) F03B 13/00, 13/12, 13/14, 13/16, 13/18, 13/20, 13/24	Search Examiner C B VOSPER Date of completion of Search 4 NOVEMBER 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASE WPI	Documents considered relevant following a search in respect of Claims :- 1 TO 16

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
A	GB 2081387 A	(VICKERS) whole document - shows flexible chambers interconnected by one-way valves but not located along a gradient below sea level	1, 2, 10
A	GB 2061395 A	(FRENCH) whole document - shows flexible chambers interconnected by one-way valves but not located along a gradient below sea level US Equivalent = 4375151	1, 2, 10
A	GB 1580805	(FRENCH) whole document - shows flexible chambers interconnected by non-return valves but not located along a gradient below sea level US Equivalent = 4164383	1, 2, 10
A	WO 86/06139	(HYDRO) Figures 3B to E, 4B and 9 in particular - show flexible chambers located along a gradient but not below sea level so as to be operated by waves	1, 2, 10
A	WO 84/00583	(HERTZ) whole document - shows flexible chambers interconnected by one-way valves but not located along a gradient belong sea level	1, 2, 10
A	US 3989951	(LESSTER/WESTINGHOUSE) whole document - shows flexible chambers connected by one-way valves but not located below sea level along a gradient	1, 2, 10

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 10103215
PUBLICATION DATE : 21-04-98

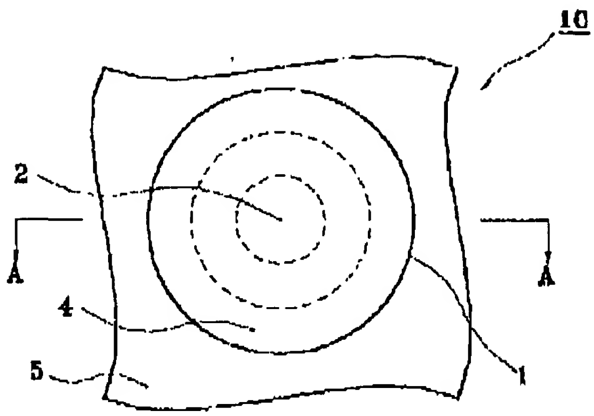
APPLICATION DATE : 24-09-96
APPLICATION NUMBER : 08251556

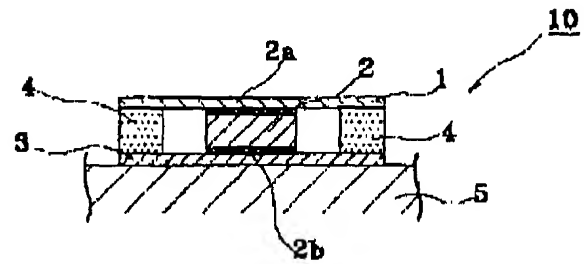
APPLICANT : MURATA MFG CO LTD;

INVENTOR : NAKAMURA TAKESHI;

INT.CL. : F03B 13/14 H02N 2/00

TITLE : WAVE MOTION GENERATOR





ABSTRACT : PROBLEM TO BE SOLVED: To provide a wave motion generator which is miniaturized and easy to maintain.

SOLUTION: A wave motion generator 10 comprises a circular wave receiving base plate 1, a cylindrical piezoelectric element 2 positioned approximately at the central part of the other main face of the wave receiving plate 1, a mounting plate 3 which pinches and holds the piezoelectric element 2 with the wave receiving plate 1 and an enclosure member 4 which covers the periphery of the side face of the piezoelectric element 2 spacing apart from the side face, and the wave motion generator 10 is fixed by adhering mounting plate 3 to a fixing base 5.

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

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(43)公開日　平成10年(1998) 4月21日

(51)Int.Cl.⁶	識別記号	F I	
Ｆ０３Ｂ　13/14		Ｆ０３Ｂ　13/14	
Ｈ０２Ｎ　2/00		Ｈ０２Ｎ　2/00	Ａ

審査請求　未請求　請求項の数２　ＯＬ　（全　４　頁）

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(22)出願日　平成8年(1996) 9月24日

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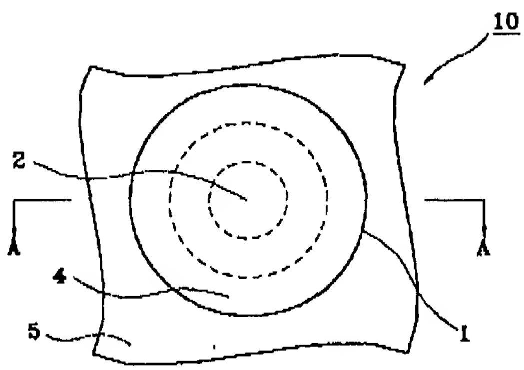
(54)【発明の名称】　波動発電装置

(57)【要約】
【課題】　小型化され、メンテナンスも容易な波動発電装置を供給する。
【解決手段】　波動発生装置１０は、円形状の波受け基板１と、波受け基板１の他方主面の略中央部に配設された円柱状の圧電素子２と、圧電素子２を波受け基板１とともに狭持するための取付基板３と、圧電素子２の側面と間隙を持って側面周囲を覆う包囲材４とから構成され、波動発電装置１０は固定台５に取付基板３を接着することにより固定される。



【特許請求の範囲】

【請求項1】 波の運動エネルギを電気エネルギに変換する波動発電装置であって、一方主面で波を受ける波受け基板と、前記波受け基板の他方主面に配設され、前記波受け基板が波を受けたときに生じる変位を電気信号に変換する圧電素子と、からなることを特徴とする波動発電装置。

【請求項2】 前記波受け基板は、前記圧電素子との接触面において平面でありかつ一方主面を凹面形状としたことを特徴とする請求項1に記載の波動発電装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は波動発電装置に関するものである。

【0002】

【従来の技術】従来の波動発電装置としては、

①波の圧力によって水車やプロペラなどを回転させることにより発電するもの

②波の上下運動により浮遊体を上下運動させ、その上下運動により回転運動を発生し、この回転運動により発電するもの

などが一般的に知られている。

【0003】

【発明が解決しようとする課題】しかしながら、上記従来の波動発電装置は、いずれも回転運動を電気エネルギに変換するものである。つまり、装置として回転体を有し、さらに、回転を電気エネルギに変換するための変換器も必要となり、装置全体が大型となっていた。

【0004】また、水車やプロペラなどの羽根部分に汚れが存在すると、波から受けることのできる圧力の大きさも小さくなるため、羽根の表面を定期的に清掃しなければならない。しかし、羽根形状は一般的に複雑であり、清掃等のメンテナンスに多大な労務を費やすことになりコスト高となっていた。

【0005】さらに、回転体の回転がなめらかである必要もあり、回転体の回転軸のメンテナンスも必要となり、これもコスト高の要因となっていた。

【0006】本発明は上記問題点を解決することを目的とするもので、小型化され、メンテナンスも容易な波動発電装置を提供することにある。

【0007】

【課題を解決するための手段】上記目的を達成するために、本発明は、波の運動エネルギを電気エネルギに変換する波動発電装置であって、一方主面で波を受ける波受け基板と、波受け基板の他方主面に配設され、前記波受け基板が波を受けたときに生じる変位を電気信号に変換する圧電素子と、からなることを特徴としている。

【0008】また、波受け基板は、圧電素子との接触面において平面でありかつ一方主面を凹面形状としたことを特徴としている。

【0009】これにより、波動発電装置が1枚の波受け基板と圧電素子のみで構成され、かつ、圧電素子自体で変位を電気エネルギに変換するため、装置全体の小型化が図れる。

【0010】また、波受け基板の一方主面に凹部を設けることにより波の逃げが無くなり、波の圧力を電気エネルギに変換する効率が高まるばかりでなく、波の圧力の向きと波受け基板の平面が垂直でなくても十分な波の圧力が得られ、電気エネルギへの変換効率も安定する。

【0011】さらに、波受け基板が平面または凹面の連続面であるため、清掃等のメンテナンスも容易である。

【0012】

【発明の実施の形態】以下、本発明の実施の形態を図面を参照して説明する。図1，図2に本発明の第1の実施の形態に係る波動発電装置10を示す。波動発生装置10は、円形状の波受け基板1と、波受け基板1の他方主面の略中央部に配設された円柱状の圧電素子2と、圧電素子2を波受け基板1とともに狭持するための取付基板3と、圧電素子2の側面と間隔を持って側面周囲を覆う包囲材4とから構成され、波動発電装置10は固定台5に取付基板3を接着することにより固定される。

【0013】円柱状の圧電素子2には、上面および下面にそれぞれ電極2ａ，２ｂが形成されており、上面から下面に向かって、または、その逆方向に向かって分極されている。

【0014】ここで、波受け基板1の一方主面に波の圧力が加わると波受け基板1が変位する。この波受け基板1の変位が圧電素子2に伝達し、圧電素子2から電気エネルギが発生する。この電気エネルギを電極2ａ，２ｂからリード線（図示せず）などにより取り出して波動発電装置10が発電装置として機能する。

【0015】次に、図3に本発明の第2の実施の形態に係る波動発電装置20を示す。波動発生装置20は、円形状の波受け基板21と、波受け基板21の他方主面の略中央部に配設された円柱状の圧電素子22と、圧電素子22を波受け基板21とともに狭持するための取付基板23と、圧電素子22の側面と間隔を持って側面周囲を覆う包囲材24とから構成され、波動発電装置20は固定台25に取付基板23を接着することにより固定される。

【0016】波受け基板21は、圧電素子22と接触している部分で平面形状を有しており、かつ、波受け基板21の一方主面に凹面形状を有する構造となっている。

【0017】円柱状の圧電素子22には、上面および下面にそれぞれ電極22ａ，２２ｂが形成されており、上面から下面に向かって、または、その逆方向に向かって分極されている。

【0018】ここで、波受け基板21の一方主面に波の圧力が加わると波受け基板21が変位する。この波受け基板1の変位が圧電素子22に伝達し、圧電素子22か

ら電気エネルギが発生する。この電気エネルギを電極22a，22bからリード線（図示せず）などで取り出して波動発電装置20が発電装置として機能する。

【0019】上述の実施の形態で示した波動発電装置は、図面で示すとおり簡単な構成からなり、かつ、圧電素子自体で変位を電気エネルギに変換するため、装置全体が小型化される。

【0020】また、波を受ける部分が平面または1方向の凹面であるため、清掃等のメンテナンスも容易である。

【0021】さらに、第2の実施の形態においては、波受け基板に凹部を設けることにより波の逃げが無くなり、波の圧力を電気エネルギに変換する効率が高まるばかりでなく、波の圧力の向きと波受け基板の平面が垂直でなくても十分な波の圧力が得られ、電気エネルギへの変換効率も安定する。

【0022】尚、上述の実施の形態で示した波動発電装置において、波受け基板1は円形状のものを示したが、四角形状や他の多角形状でもよく、構造は特に限定されるものではない。また、材質についても特に限定されるものではないが、波受け基板自体が変位を吸収しない材質、例えば、ステンレス板などが好ましい。

【0023】また、圧電素子の形状も円柱形状に限定されるものではなく、四角柱状などの多角柱形状でもよく、また、圧電素子を多層構造としてもよく、目的・用途に応じて適宜選択できるものである。

【0024】また、取付基板と固定台は別体で形成されているが、一体形成されていてもよい。つまり、固定台が取付基板を兼用してもよい。

【0025】また、波動発電装置は水中に配置されて使用されるものであるため、包囲材としてはシリコンリングやシリコン樹脂などの、波動発電装置内部の防水性を高めるものを用いるのが好ましい。

【0026】なお、第2の実施の形態で示した波動発電装置20において、波受け基板21が凹部を有した構造となっているが、第1の実施の形態に示す波受け基板1の一方主面上に凹状となる部材を別途設けて波受け基板全体を凹状としてもよい。

【0027】また大電力を必要とする場合は、本発明の波動発電装置を、固定台上にタイル貼りのように複数個接続して配置してもよい。

【0028】

【発明の効果】以上のように、本発明による波動発電装置では、波動発電装置が1枚の波受け基板と圧電素子のみで構成され、かつ、圧電素子自体で変位を電気エネルギに変換するため、装置全体の小型化が図れる。

【0029】また、波受け基板の一方主面に凹部を設けることにより波の逃げが無くなり、波の圧力を電気エネルギに変換する効率が高まるばかりでなく、波の圧力の向きと波受け基板の平面が垂直でなくても十分な波の圧力が得られ、電気エネルギへの変換効率も安定する。

【0030】さらに、波受け基板が平面または凹面の連続面であるため、清掃等のメンテナンスも容易である。

【図面の簡単な説明】

【図1】本発明の第1の実施の形態に係る波動発電装置の構造を示す平面図である。

【図2】図1におけるA－A線断面図である。

【図3】本発明の第2の実施の形態に係る波動発電装置の構造を示す断面図である。

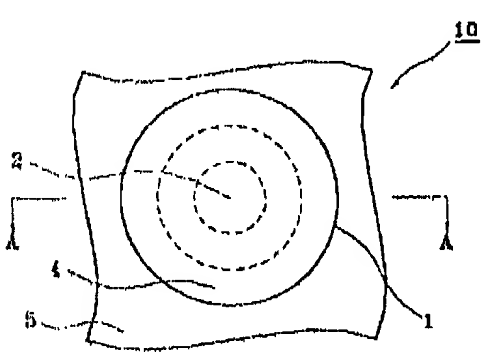
【符号の説明】

1，21　波受け基板

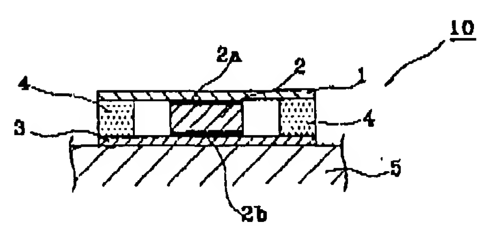
2，22　圧電素子

10，20　波動発電装置

【図1】



【図2】



【図3】